**Energy Exercise**

The goal of this exercise is for you to be able to indentify types of energy and energy transformations associated with movement and/or change of matter. To accomplish this goal we are going to draw analogies between energy flow and transformation in two real-world situations.

Principles:

1. Gravitational energy, thermal energy and/or chemical **energy** drive all movement and change of matter on Earth.

4**. Energy** is needed to break bonds and is released when bonds form.

Types of energy:

1. Kinetic energy; The energy a body has due to its movement.

1. Potential energy: The energy stored in a body due to its position or arrangement of its parts. Potential energy is converted into kinetic energy when matter moves or chemical energy when matter changes.
2. Gravitational energy: the energy that draws objects together. On earth most gravitational energy is due to the attraction between the earth and other objects.
3. Thermal energy: the energy of a body that results from the movement of molecules within the body. Recall that the movement of molecules is a measure of temperature.
4. Chemical energy: the energy that is due to the arrangement of atoms and molecules.
5. Solar energy: Energy derived from the sun. On earth, this energy is converted into thermal energy or chemical energy by photosynthesis.

**The Flood**

Water, evaporated from the oceans, was carried high into the atmosphere by air currents. As the air rose over the Rocky Mountains, it cooled and the water condensed to form dark clouds. By late afternoon, lightening flashed and along with the roar of thunder came a heavy down pour. Water rushed over bare rock and thin soil to a small stream leading to a high mountain lake that formed behind a pile of rocks from a landslide that blocked the valley hundreds of years ago.

The lake, 12,000 feet above sea level, is accessible only by a steep trail 18 miles away from the nearest trailhead. Few people are willing to make the trek, so the cutthroat fish population was thriving until a bear, hunting for fish, kick loose one large rock. Water came rushing through the hole where the rock had been lodged and soon the rocks and water that had been captured behind it were rushing down the mountain slope toward a village below. People heard the roar in time to rush to safety up the sides of the valley. They managed to escape without harm but all the buildings in the village were destroyed.

Part 1. Recognizing types of energy

Complete table1 by identifying the energy involved with each aspect of the flood. Two of the boxes have been filled in as examples. There may be several equally correct answers for each box. For example, in the first box in the right hand column, one could write solar energy instead of thermal energy. However, it would be incorrect to write gravitational energy because gravitational energy does not cause evaporation.

|  |  |
| --- | --- |
| **The Flood** | **Energy used or transformed** |
| Evaporation by solar radiation | *thermal & chemical energy* |
| Water condenses | *chemical energy* |
| Water in a mountain lake | *potential energy* |
| Bear kicked loose a rock to start the flood | *turning potential gravitational to kinetic energy* |
| Stream carries water and rock to village | *kinetic energy* |
| Destroying buildings | *kinetic energy* |

**Table 1**

**Mary’s Morning Coffee**

Tree rings show the annual growth of trees. During the warm months, trees draw water from the ground and carbon dioxide from the atmosphere to grow by the process of photosynthesis. Plants release that energy during respiration and use the released energy, in part, to build more complex molecules and grow. Some trees in the Rocky Mountain National Forest grew to enormous heights before the infestation of bark beetles destroyed it and most of the surrounding trees. Pete had a permit to cut down the dead pines, haul them away and sell the wood for firewood. Mary, who lived in a cabin high in the mountains, bought ten cords of the wood from Pete for $1000.00. Pete drove his truck up and down the mountain several times to get all the wood to Mary’s cabin. Mary used the wood to heat her cabin and for cooking on a wood burning stove.

Mary enjoyed her quit existence and like to muse about connections as she struck a match to start her wood-burning stove, make her morning coffee and watched the sunrise.

Complete table 2 in the same way you completed table 1.

|  |  |
| --- | --- |
| **Mary’s Morning Coffee** | **Energy used or transformed** |
| Photosynthesis using solar radiation | *Solar energy transformed to chemical potential energy.* |
| Respiration | *chemical energy used for growth.* |
| Wood | *chemical potential energy* |
| Driving truck | *kinetic energy* |
| Starting a fire with a match | *transforming chemical potential to thermal kinetic energy* |
| Burning wood | *thermal energy* |
| Making coffee | *transforming thermal energy to chemical energy.* |

Table 2

**Part 2. Alignment**

In many ways, the two stories above are analogous because they both involve movement and change caused by the flow and transformation of energy. They correspond because the are can be explained by the same causal principles or play the same roles in the causal processes. Table 3 lists some features and relationships of ther flood. Table 4 lists some feaures and elelments for Mary’s morning coffee. Please complete table 3 by filling in the corresponding elements from table 4 and describe the energy used or transformed.

|  |  |  |
| --- | --- | --- |
| **The Flood** | **Mary’s Morning Coffee** | **Energy used or transormed** |
| Evaporation by solar radiation | *Photosynthesis using solar radiation* | *Both are driven by solar energy* |
| Water condenses | *Respiration* | *Both release chemical energy* |
| Water in a mountain lake | *Wood* | *Both have potential energy* |
| Bear kicked loose a rock to start the flood | *Starting a fire with a match* | *Both transform potential to kinetic energy* |
| Stream carries water and rock to village | *Burning wood* | *Both transforming potential to kinetic energy* |

Table 3.

|  |
| --- |
| **Mary’s Morming Coffee** |
| Wood |
| Starting a fire with a match |
| Burning wood |
| Photosynthesis using solar radiation |
| Respiration |

Table 4

**Part 3. Finding the Limits of an Analogy**

While analogies are very useful, they all have their limits. In this case, we want to highlight some components that are different between the Flood and Mary’s Cup of Coffee.

There are components of the Flood that do not properly correspond to components of the Mary’s cup of coffee. Note that there can be aspects of components that both match and mismatch. For example, chemical potential and gravitational potential match in the sense that they are both forms of potential energy and they mismatch in the sense that one is chemical and the other is gravitational. Each pair listed in table 5 mismatch in one or more ways. Complete the table by describing the differences.

|  |  |  |
| --- | --- | --- |
| **The Flood** | **Mary’s Coffee** | **Why are they different** |
| Condensation | Photosynthesis | *Condensation releases energy, photosynthesis stores energy.* |
| Rainfalls on the mountain | Trees grow | Precipitation is caused by gravity, trees growing stores chemical energy |
| The flood flows down hill | Pete drives up the hill | Water flowing downhill decreases potential energy, driving up hill increases potential energy |

Table 5

**4.** Assessment – Below are two possible questions. We would probably use only one.

1. How, if at all, would higher global temperatures change the chemical and/or kinetic energy in the water cycle?

Higher temperatures will increase evaporation. When the water vapor condenses during storms, it releases chemical energy that is transformed into kinetic energy of the storm, making storms more violent.

2. Complete the box and arrow diagram below by writing chemical, gravitational or both in the empty boxes. These boxes represent the energy that causes movement or change from one reservoir to another.

